

CLAIMS

1. A method of work piece processing a work piece by pulsed electric discharges in solid-gas plasmas comprising the steps of:
- providing a vacuum in a processing chamber,
 - 5 - providing sputtering and reactive gases in the processing chamber,
 - producing pulsed discharges in gas and vapor located between first electrodes including an anode and a magnetron sputtering cathode for creating blobs of the gas and partially ionized solid plasma, the blobs moving or spreading from a region at a surface of the magnetron sputtering cathode towards second electrodes including the work piece and the anode, and
 - 10 - applying a potential to the work piece,
- characterized in**
- that the potential is applied to the work piece in such a way that a pulsed current comprising biasing pulses arises between the second electrodes, and
 - that the biasing pulses are produced by both the pulsed discharges and the work piece potential,
 - 15 the biasing pulses of the pulsed current between the second electrodes having or appearing with the same frequency as the pulsed discharges.
2. A method according to claim 1, **characterized in** that the potential is applied to the work piece so that biasing discharges are produced between the anode and the work piece when said plasma blobs have spread to regions at the anode and at the work piece, the pulsed current
- 20 comprising the biasing pulses being the current of the biasing discharges.
3. A method according to claim 1, **characterized in** that the potential is applied to the work piece in such a way that the biasing pulses coincide in time with pulses to create the pulsed discharges between the first electrodes.
4. A method according to claim 1, **characterized in** that the potential is applied to the
- 25 work piece in such a way that the biasing pulses exist as long as a plasma exists.
5. A method according to claim 1, **characterized in** that the potential is applied to the work piece in such a way that the biasing pulses start simultaneously with the pulsed discharges between the first electrodes in which plasmas are created and are terminated after the end of the decay of the plasmas created.
- 30 6. A method according to claim 1, **characterized in** that the potential applied to the work piece is the same as the potential of the magnetron sputtering cathode.
7. A method according to claim 1, **characterized in** that the work piece is directly electrically connected to the magnetron sputtering cathode, at least during a first period of each driving pulse creating the pulses between the anode and the magnetron sputtering cathode.

8. A method according to claim 1, **characterized in** that the work piece is electrically connected to the magnetron sputtering cathode through a resistor, in particular a resistor having a variable resistance.

9. A method according to claim 5, **characterized in** that the resistor has a resistance of the range of 0 - 10 kOhm.

10. A method according to claim 1, **characterized in** that the work piece is short connected to the magnetron cathode for a period of 0.1 - 10 μ s after magnetron discharge breakdown.

11. A method according to claim 10, **characterized in** that after said period the work piece is disconnected from magnetron cathode to have a floating potential.

12. A method according to claim 10, **characterized in** that after said period the work piece is connected to the magnetron sputtering cathode by a variable resistor.

13. A method according to claim 1, **characterized in** that for each driving pulse for producing the magnetron discharges the work piece is disconnected from the magnetron sputtering cathode before magnetron discharge break down and thereafter is connected to the anode for a period of 0.1 - 100 μ s after magnetron discharge break down and thereafter is again connected to the magnetron sputtering cathode.

14. A method according to claim 1, **characterized in** that the potential is applied to the work piece by periodically connecting the work piece to the anode through a resistor, in particular a resistor having a variable resistance.

15. A method according to claim 14, **characterized in** that the resistor has a resistance of the range of 0 - 10 kOhm.

16. A method according to claim 1, **characterized by** setting parameters of the biasing pulses depending on the surface of the magnetron sputtering cathode.

17. A method according to claim 1, **characterized in** that the voltage of the biasing pulses is set to be in the range of - 5000 V to + 5000 V, in particular substantially - 500 V or +500 V.

18. An installation for work piece processing by pulsed electric discharges in solid-gas plasmas comprising:

- a process chamber,
- a work piece placed in the process chamber,
- a system for maintaining a vacuum in the process chamber,
- a system for providing sputtering and reactive gases to the process chamber,
- first electrodes including an anode and a magnetron sputtering cathode placed in or integrated in the process chamber,

- second electrodes including the anode and the work piece,
- a plasma pulser circuit including the first electrodes for creating gas and partially ionized solid plasma blobs by pulsed discharges in the gases and vapor in the processing chamber in the region between the first electrodes, the plasma blobs moving or spreading from a region at a surface of the magnetron sputtering cathode towards the work piece and the anode,
- a biasing pulser circuit including the work piece for applying an electric potential to the work piece,

characterized in that the plasma pulser circuit and the biasing pulser circuit are powered by the same pulser.

- 10 19. An installation according to claim 18, **characterized by** a work piece switch connected in a line between the work piece and the cathode.

20. An installation according to claim 19, **characterized by** an impedance device or a resistor, in particular an impedance device having a variable impedance or a resistor having a variable resistance, connected in the line.

- 15 21. An installation according to claim 20, **characterized in** that the impedance device or resistor has an impedance or a resistance of the range of 0 - 10 kOhm.

22. An installation according to claim 18, **characterized by**

- a work piece switch connected in a line between the work piece and the magnetron sputtering cathode,
- 20 - a control and monitoring unit connected to the work piece switch for commanding it, the control and monitoring unit commanding the work piece switch to short-connect the work piece through said line to the magnetron sputtering cathode for a period of 0.1 - 10 μ s after each magnetron discharge breakdown.

23. An installation according to claim 18, **characterized by**

- 25 - a cathode switch,
- an anode switch connected in a line between the work piece and the anode,
 - a control and monitoring unit connected to the switches and commanding them so that the work piece is disconnected from the magnetron sputtering cathode by the cathode switch before the magnetron breakdown in creating a discharge between the anode and the magnetron sputtering
 - 30 cathode and thereafter is connected by the second work piece switch to the anode for a period of 0.1 - 100 μ s after magnetron discharge break down.

24. An installation according to claim 18, **characterized by**

- an anode switch connected in a line between the work piece and the anode,
- a resistor, in particular a resistor having a variable resistance, connected in the line,

- a control and monitoring unit connected to the anode switch for commanding it to connect the work piece to said potential, the control and monitoring unit periodically connecting the work piece to the anode through the resistor to make the work piece adopt the potential of the anode.

25. An installation according to claim 24, **characterized in** that the resistor has a resistance of the range of 0 - 10 kOhm.

26. An installation according to claim 18, **characterized in** that the anode includes walls of the process chamber and is the same for plasma discharges and biasing pulses.

27. An installation according to claim 18, **characterized in** that the anode is an electrode placed inside the process chamber, electrically insulated therefrom and is the same for plasma discharges and biasing pulses.

28. An installation according to claim 19, **characterized in** that the anode includes two separate anode parts located the inside process chamber, electrically insulated therefrom it and are different for plasma discharges and biasing pulses.

29. An installation according to claim 18, **characterized in** that the plasma generating discharges and work piece processing discharges are produced by same electric pulser.

30. An installation according to claim 18, **characterized in** that the plasma generating discharges and work piece processing discharges are produced by different electric pulsers.

31. An installation according to claim 18, **characterized by** a variable resistor connected in a line between the work piece and a terminal of an energy supply to be selectively bypassed by a bypass line.

32. An installation according to claim 18, **characterized by** a pulser or pulsed generator including a charged capacitor.

33. An installation according to claim 18, **characterized in** that the processing/biasing pulses are synchronized with the plasma generating pulses.

34. An installation according to claim 18, **characterized in** that the connecting and disconnecting of the work piece from electrodes is performed by solid-state switches.